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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON December 6, 1918

Confidential Bulletin 19

1. Airplane Development

The work on the Parker variable camber wing, in cooperation with the National Advisory Committee for aeronautics, has progressed sufficiently that conclusions may be drawn as to the functioning and strength of the device. The shapes assumed throughout the range of motion are satisfactory; no increase in weight over the standard wood rib is necessary; other wing details are left unaltered; special care must be taken in the design to obtain proper stability; no difficulty should be encountered in the behavior or attachment of the fabric; and while the device is not applicable to all types of aerofoils, the restrictions imposed by the structure leave an ample range of types available.

Compression and cross-bending tests of cable-reinforced wood struts and beams were made and it was found that the specific strength was not materially increased. The possible utilization of Cieba wood as an insulator for refrigerator cars has been investigated. In cross bending this material shows a modulus of rupture of 1,470 lb. per sq. in., an ultimate strength in compression of 790 lb. per sq. in., but only 190 lb. per sq. in. in the direction perpendicular to the grain. The weight of the samples submitted was 6.7 lb. per cu. ft. and the thermal conductivity 7.6 B.T.U. per day per sq. ft. per degree F per inch thickness.

2. Welding Investigations

In cooperation with the Welding Sub-Committee of the Emergency Fleet Corporation, tensile, torsion, cold bend, and repeated stress tests were made on 1/2" welded ship plates. Tensile and bending tests were made on 3/4" welded ship plates containing 0.10% sulphur; the joints were 45° double bevel, butt welds. No difficulty was experienced in welding these plates and there was no undue boiling of the metal. The tests show that the manner in which the welding metal is deposited determined to a large extent the strength of the weld, the three-layer weld being 25% stronger than the single-layer weld. Tensile tests were made on 1/2" salvaged ship plates to determine the effect of punching and filling rivet holes by welding, the punched holes being 13/16" in diameter in a single row with standard "oil-tight" spacings. These holes were filled by placing a plug of less

thickness than that of the plate in each hole and depositing welding metal on each plug. The strength thus obtained amounted to 86% of the tensile strength of the plate as compared with 69% applying to the condition before filling of the holes. Two sets of 1" ship plates with butt joints were welded, one with direct and the other with alternating current. Samples welded with direct current had the greater tensile strength and in cold bend tests were capable of being bent through an angle three times that for the alternating current specimens.

3. Non-Scatterable Glass

Samples of the so-called non-scatterable glass, consisting of a sheet of celluloid "welded" to one side of a sheet of glass, were tested under rifle fire, impact, and cross bending. The action of the material was very satisfactory and when placed so that the celluloid was on the tension side, as should be the case in practice, the coated glass was about 40% stronger than the uncoated glass, for the same thickness of glass in each case.

4. Welded Steel Tube

Tensile and compression tests of round steel tube from 1" to 2-1/2" in diameter and from 0.03" to 0.07" in thickness of wall, and also of square tubing of approximately the same sizes showed that cylindrical tubes used as struts develop compressive stresses about equal to the strength of the material. The square tubes, especially in the larger sizes, showed decidedly inferior performance, lacking apparently the lateral stiffness required to permit of their functioning satisfactorily as struts. The electric welds used had efficiencies varying between 50 and 100%.

5. Aluminum Tubes

A summary of the results of alternating stress tests on aluminum tubes shows that heat treatment has increased the tensile and static cross-bend strength while reducing the ductility of the material and its resistance to alternating stress.

6. Metallurgical Investigations and Tests

Sections of cast gun steel were submitted to various heat treatments and examined microscopically after each step in order to develop the best time and temperature requirement for grain refinement. Specimens of "flaky" steel examined after repeated stress test to destruction showed conclusively that the coarse crystalline flake acts

as a centre for the detail break which the repeated stress brings about. Study has been given to the cause of corrosion and breaking of electrodes in porcelain spark plugs and steps have been taken to aid the manufacturers in overcoming the difficulty. A study is also in progress on the corrosion of aluminum carburetors on airplane engines. A preliminary report with recommendations has been sent to the Engineering Division of the Ordnance Department with respect to the investigation of copper compression cylinders and a second report is nearly ready. Miscellaneous tests carried on during the month of October included several aluminum solders, determination of the melting point of 8 platinum substitute alloys, semi-steel cast tools, 4 gun steel samples illustrative of variations in machining properties, hot forged and cold drawn horseshoe nails with respect to the preparation of specifications, samples of brass hardware for gas masks, chrome vanadium spring steel, 11 samples of electrolytic lead plate, 8 samples of zinc plating, 6 airplane wing frame members, 1 sample of magnet steel.

7. Investigation of Lubricants

In connection with a general and extensive investigation of lubricants, which is in progress, work has been begun on the correlation of friction and viscosity of oils and the Bureau's friction testing machine is being applied to that work. Report has been made to the American Society for Testing Materials on the standardization of the Tag closed flash-point tester. The work of investigating viscosimeters has resulted in a paper on standardization of the Ubbelohde viscosimeter for gasoline and the Barbey viscosimeter which is standard in France is now undergoing determination of its essential dimensions preparatory to complete standardization. The Redwood viscosimeter is standard for use in England and two of these instruments which the Bureau now has are being standardized.

8. Miscellaneous Physical Tests

A 3-1/4" stranded steel cable was tested in tension and developed an ultimate strength of 742,000 lb. Proof loads were applied to 5-5/8" and 8" recoil piston rods. Two cast steel tractor wheels were given radial compression tests of 100,000 lb. and then tested to destruction in skid tests. The results indicated the changes of design required. Strength tests were carried out on Ordnance towing chains, a three-link stamped chain of 1" stock, and 11 vehicle chains, the latter showing perfect welds and very satisfactory strength.

A varied line of materials given physical tests during the past month included lubricating oils, sole leather, harness and strap leather, water hose, air

hose, suction hose, canvas belting, solid tires, pneumatic cord and fabric tires, inner tubes for truck tires, rubber covered wire, rubber cements, rubber packing for airplane gas tanks, dredging sleeves, rubber dam and fire hose.

The extensive tests begun in September to determine the physical properties of 60 sides of leather, including harness, strap, bag, latigo, and elk skin were completed and report transmitted to the Sub Committee on Standardization of Specifications for Leather and Leather Goods of the Office of the Chief of Staff. Determinations made included tensile strength, ultimate elongation, tearing resistance, and buckle and shearing resistance.

At the request of the Ordnance Department of the Army, the Bureau assisted in tests at a proving ground to obtain data regarding the relation between length of recoil, temperature, and viscosity of oil in a recoil cylinder.

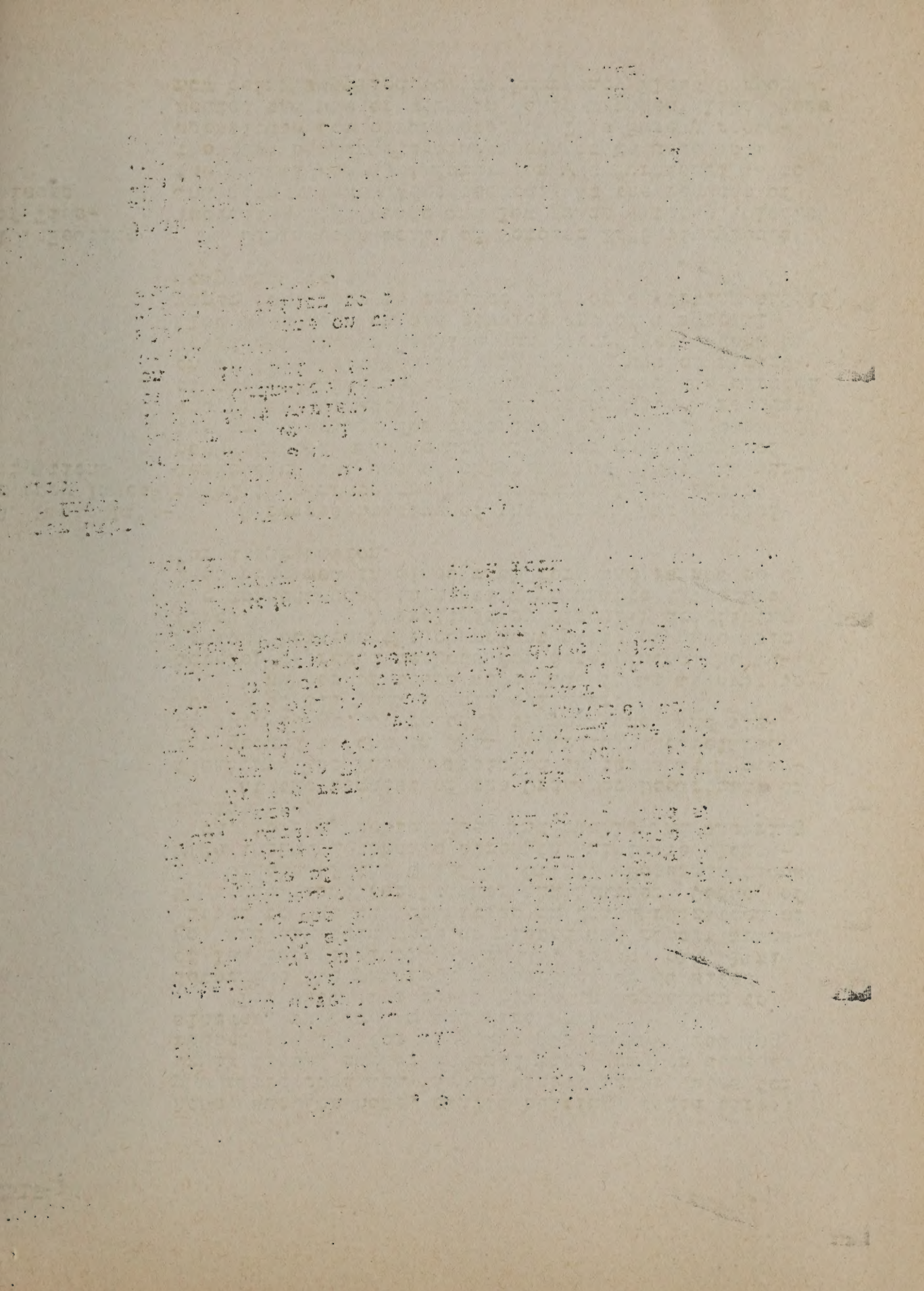
A number of tests were made in an attempt to develop improved methods for determining the adhesions between the component parts of pneumatic tires. A preliminary circular describing the methods used in testing pneumatic tires has been prepared in mimeograph form and is now ready for distribution.

9. Paper Laboratory Investigations

A representative of the Bureau has participated in conferences on the general subject of decreasing the use of chlorine for bleaching purposes in the manufacture of paper on account of the great demand for chlorine for war purposes of the widest variety. In connection with a request of the Ordnance Department, the Bureau has carried on an investigation looking to the use of a cardboard carton for machine gun cartridges. Work has also been done on the development of a special paper container to replace tin for exporting saddle soap and grease.

10. Testing of Timepieces

During the month of October 1275 timepieces including high grade and low grade watches, clocks, and stop watches were tested. At the request of the Signal Corps, information was furnished as to the best obtainable timepieces to be used as a substitute for chronometers. This Bureau recommended the use of certain "ship watches" like those now being supplied to the Emergency Fleet Corpora-



tion under definite specifications prepared in co-operation with this Bureau and issued by the Emergency Fleet Corporation. The Signal Corps was informed that the Bureau would make acceptance tests of any watches desired.

11. Weighing Scales

At the request of the authorities of the Government Nitro Plant at Charleston, West Virginia, one of the Bureau mine scale testing trucks then operating in the neighborhood visited the plant and made a thorough inspection and test of 85 scales on which many adjustments were required and carried out. These scales had just been installed and operation of the plant was to be inaugurated within a few days. Inspections made by the Bureau revealed some scales of faulty manufacture, some incorrectly installed, and others not well suited for the work for which they were to be used. At the conclusion of the inspection, the Bureau's representatives instructed a representative of the plant in the use, inspection, and maintenance of the scales under his charge. The importance of this service will be appreciated when it is considered that the capacity of the plant amounts to several hundred thousand pounds of powder daily.

The Bureau would emphasize the fact that the use of adequate specifications in the purchase of weighing scales is eminently desirable, and that the manufacturers' regular product cannot safely be accepted without examination and calibration by experts.

12. Other Weights and Measures Work

Special information was supplied the Navy Department relative to the purchase of a new contact measuring machine. An investigation is in progress regarding the field testing of natural gas meters under the control of the Fuel Administration. The question of dental amalgams with especial reference to their coefficient of thermal expansion with respect to that of human teeth is the subject of an extended research. Two dry gas meters were tested for the Chemical Warfare Service, a 3-inch range dial for the Washington Navy Yard, and 20 dilution pipettes for the Field Medical Supply Depot, of which latter only 4 were found acceptable.

13. Cement and Concrete Investigations

The investigations already reported on the performance of concrete oil storage tanks, after being in progress for two weeks showed losses of

oil under a 25 foot head ranging from 0.20 to 5.88 percent. All observations were corrected to a temperature of 60°F. At the request of the Shipping Board a series of tests have beeniinitiated to determine the effect on concrete of the addition of various percentages of Puzzolan to the cement material, which, it is claimed, may be added up to 50% of the cement content without materially affecting the concrete. A design to accelerate the hardening of concrete by the use of perforated pipes delivering steam within the mass has been submitted for investigation. The apparatus has been set up and results may be expected within a month. The accelerating of the hardening of concrete by this method if successful, will of course, be of great military value.

14. Heat and Thermometry

Tests recently completed in the Heat Division include: 1 rare metal thermocouple; melting point of sample of fire clay; 15 airplane thermometers of various types; heat of combustion of 12 samples of airplane fuels; heat of combustion of 3 samples of fuel oil; freezing point of balloon coating material; a 16-gallon "Calorox" insulated liquid air container; small vacuum jacketed liquid air containers; liquid air for special military tests.

At the request of the Inspection Division, Bureau of Aircraft Production, a vibration test was made to determine the relative effedt of continued vibration on the indications of airplane thermometers of different makes. Three vapor pressure and three liquid filled thermometers were submitted to the test, which lasted approximately 100 hours. Readings at 0°, 40°, 80°, and 100° were taken before the test and at intervals of approximately every 25 hours. The instruments did not appear to be appreciably affected by the vibration.

15. Gun Firing Problems

During the month experts from the Bureau cooperated with the Bureau of Ordnance of the Navy Department in taking observations during the experimental firing of the U.S.S. New Mexico. Using the time of the closing of the firing circuit as zero time, measurements were made of the time of breaking of the primer bridge, time of explosion of the primer, time of the beginning of the recoil, time at which the nose of the projectile reached the muzzle of the gun, time at which the rifling band reached the muzzle of the gun; the last two measurements

permitting a determination of the muzzle velocity of the shell. In addition, measurements were taken of the jump of the gun, the whip of the turret, and the recoil of the gun, especial care being taken to determine the amount which takes place before the emergence of the projectile. The data on the recoil will permit the construction not only of the time-displacement curves, but also of curves showing the velocity and acceleration of the gun at each instant of time and at each position of the gun. As an indicator diagram of pressure in the recoil cylinders was taken, it will be possible to make a fair determination of the velocity of the shell throughout the bore of the gun, and of the pressure in the gun. Considerable time will be required to analyze the data which have already been taken.

Apparatus is being developed for making a more complete study of ballistic problems. There is now being designed and constructed apparatus for determining time-pressure curves in a gun, for measuring the pressure and velocity of the blast, and for making a photographic study of the behavior of projectiles in flight.

16. Sound Ranging Work

Recently the finishing touches have been placed on the sound ranging set which has been under construction and which it was tentatively planned to send to Italy upon completion. At the suggestion of the Engineer Corps, the plan of sending the apparatus to Italy has been abandoned owing to the signing of the armistice, and the completed apparatus is being turned over to the War Department as a part of its permanent equipment. An additional set is now being completed at the request of the Engineer Corps. Laboratory work on the development of an amplifier in connection with tests to record the earth shock from a gun has been completed and this apparatus is now ready to take to Indian Head for trial.

It should be stated in this connection that the work on sound ranging at the Bureau has been carried on in cooperation with the Chief of Engineers and the officers of his department, who have contributed much valuable advice and arranged for and assisted in carrying out all field tests.

17. Ignition Magnetos

An attempt was made to confirm the observation reported by investigators abroad that the secondary discharge of ignition magnetos has a large high-frequency component. In an experiment at the Bureau no such high-frequency currents could be detected with a wavemeter within the wave length limits of 30 to 10,000 meters.

18. Illumination Surveys

An investigation of illumination of various buildings of the Department of Commerce has been carried on during the past two months by experts of the Bureau, and it was found possible to improve in very great measure lighting conditions over the tables used by map engravers. Both the daylighting and artificial lighting conditions were found to be faulty, and a new arrangement of screen and lamp for eliminating the glare from the polished plates was devised.

19. Vacuum Tubes for Radio Work

This branch of work has recently been very greatly increased. Reference has been made to the development of cathode ray oscillographs for this work. Much other unusual equipment is required for testing the tubes and attention has been concentrated upon the development of the special circuits required. Studies of amplifiers and of the characteristics of high-frequency currents produced by vacuum tubes are in progress. To determine the suitability of tubes for use on airplanes, shaking tests have been made in the laboratory, after comparing the action of the shaking apparatus with the amount of vibration to which the tubes are subjected in actual flight.

20. Insulating Materials for Electric Instruments

In continuation of the study of insulating materials, data have been obtained during the past month with especial reference to the effects resulting from exposure of the materials to temperatures above the normal. When certain of the materials were baked for a considerable period at 50° C, noteworthy differences in electrical behavior resulted, indicating the occurrence of some change in the composition of the material. Observations of the quality of these products shows that in some samples there were cracks between the layers and it appears that the manufacturing processes are not yet by any means perfected.

21. Radio Signalling by Submarines

A long series of experiments were carried out by members of the Bureau's staff with a view to improving the present methods of marine radio communication and to effect communication with the submarine submerged. The experiments have shown that by the use of the new method, communication can be carried on under nearly all conditions better than with the ordinary antenna now in use. The new construction requires no mast and does not interfere with submergence. Under storm conditions, the ppro - jected method of communication is entirely practicable and eliminates the disadvantages attending the use of antennae under such circumstances.

22. Investigation of Protective Lighting Equipment

At the request of the Construction Division of the Army, extensive measurements were undertaken on a number of flood lighting units designed for protective illumination in the environment of ammunition depots, and munitions factories. Practical tests and demonstrations show that the flood lighting has essential defects vitiating the utility of the method to a large degree and, therefore, the Bureau has suggested unsymmetrical angle reflectors and installed such reflectors along a portion of the fence which surrounds the Bureau grounds. The results are exceedingly satisfactory and the cost of the lighting protection will be much less than with the equipment which the Army originally expected to employ.

23. Storage Batteries

In connection with this investigation, particular attention has been given to tests on cells of two types at low temperatures. It was found that below a certain temperature the output of the Edison battery is very small and that if current is forced through this battery by an external emf, the battery reverses in polarity becoming practically a dead resistance in the line.

24. Standardization of Electrical Equipment

Several representatives of the Bureau are cooperating with the General Committee of the General Staff on Standardization of Electrical Apparatus and Supplies, and extensive assistance has been given in the preparation of reports on incandescent lamps, dry batteries, transformers, watthour meters, instrument transformers, and switchboard instruments. Work is also in progress on wiring devices, line material, wires and cables, circuit breakers, and insulation materials.

35. Use of Wheat Flour in Dry Cells

After careful consideration of the possibility of substituting another material for the flour used in making paste for dry cells, the conclusion has been reached that the manufacturers should be allowed to use wheat flour that has become unfit for human consumption. Of this sort of flour, the supplyyseems to be adequate for the present purposes.

36. Wind Tunnel Investigations

Development work has been carried on for the Bureau of Aircraft Production on an 11" 20-watt self-regulating air fan for driving airplane gasoline pumps. In cooperation with the Science and Research Division of the Bureau of Aircraft Production, a double-throated venturi tube is being developed for use in the driving of Garnier spinning top inclinometers. At the request of the National Advisory Committee for Aeronautics, a study has been made of the aerodynamic characteristics of a flat plate having an aspect ratio of six. Many routine tests have been made for the Bureau of Aircraft Production on self-regulating fans for driving airplane wireless telegraph and telephone sets. Studies are being made of a new type of buoyancy and incidence meter, the operation of which is to be based on the difference in the pressures obtaining on opposite surfaces of the wing.

37. Airplane Landing Signals

Practical experiments have been carried on regarding the proposed method of signalling to an airplane in thick weather or fog to aid the pilot in making a safe landing. The induction method used, permitted the sending of very strong signals up to 1000 feet and signals readable at 3000 feet when the motor was shut off. The system has the advantage that the signals can be practically localized to the area of the landing field and if used in conjunction with the radio compass will permit of a plane being directed to an area over the landing field within which the signals from the system referred to above will provide accurate landing information.

38. General Theory of Measuring Instruments

Special study has been given certain fundamental aspects of the design of measuring instruments and it has been shown that the workmanship as judged by examination of the instrument, and the calibration errors as determined by the usual test, do not alone suffice to establish the relative utility and value of instruments of diverse design and construc-

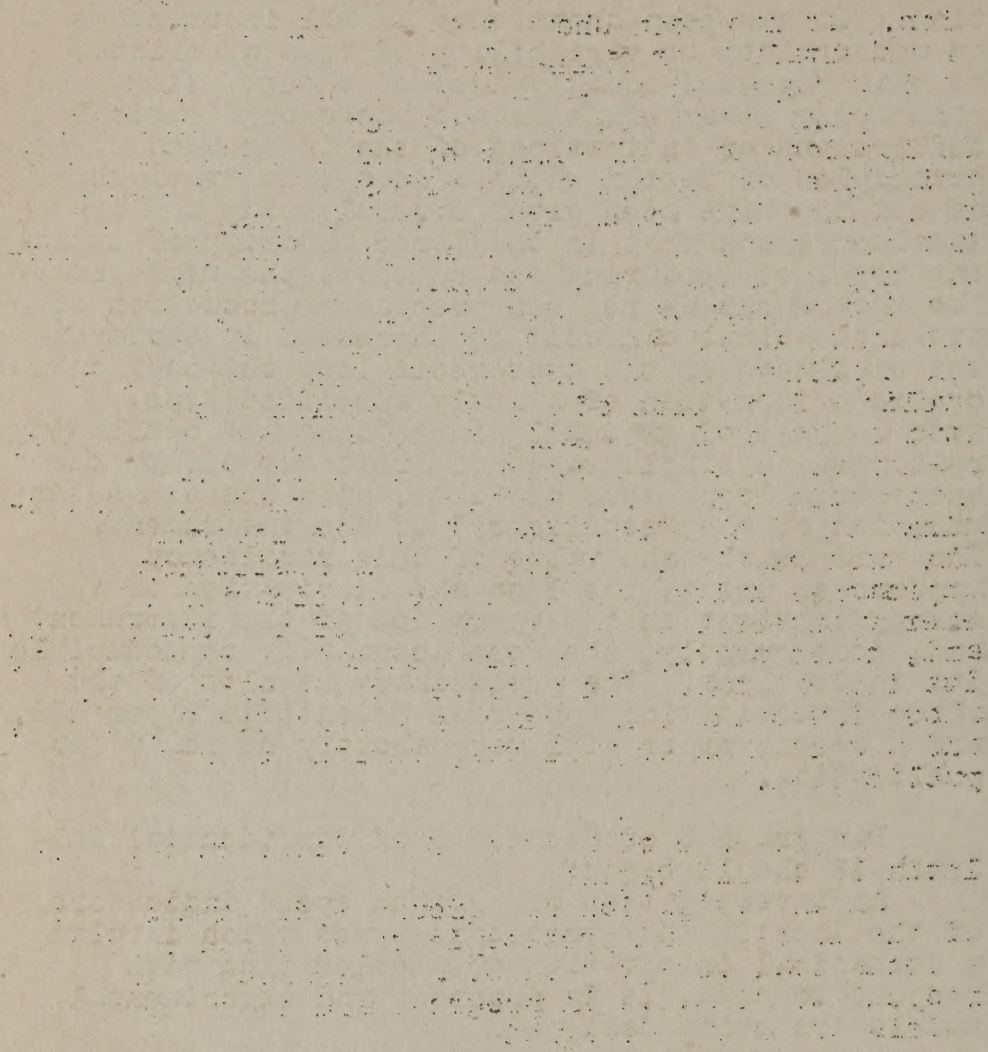
tion. It has been shown that in all instruments an uncertainty or variability of reading exists, so that repeated equal values of the quantity undergoing measurement do not occasion identical deflections or indications of the instrument. The principles of design which affect this "variancy" of reading have been given careful study and it has been shown that in the large majority of existing types of measuring instruments, the merit of the instrument as regards precise reproduction of its indications can well be expressed in terms of the smallness of the hysteresis loop obtained on cyclic calibration of a newly specified type, over a range of gradually increasing and decreasing readings. A simple ratio of areas set off by the hysteresis loop thus obtained, permits the determination of the "resiliency" of the instrument. The more nearly the value of this resiliency approaches unity, the less the dissipation of energy inherent in the operation of the instrument and, consequently, the more accurately reproducible its indications. The preliminary results of the above investigation appear in Scientific Paper 328, and a second paper will very shortly be ready for publication.

29. Erratum in Confidential Bulletin 18

Paragraph 3 of Section 6 of Confidential Bulletin 18 should begin:

An investigation of ground speed indicators of the inertia and gyroscopic types which involve a mechanical integration of acceleration with respect to time, is in progress and experimental models are being designed.

Respectfully,

S. W. STRATTON

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